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Further contributions to the taxonomy of *Armillipora* Quate (Diptera, Psychodidae) with the description of two additional new species

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Abstract

The genus *Armillipora* Quate is recorded for the first time in Brazil and Venezuela, based on the description of *Armillipora bifida* **sp. nov.** Additionally, a second new species, *Armillipora nawak* **sp. nov.**, is described from Costa Rica. Detailed illustrations and photographs of the new species are provided. Based on these findings and the existing knowledge of the genus, two species groups are proposed within *Armillipora*. Furthermore, the identification key to the males of the genus is updated.

Key Words

Psychodinae, Moth flies, Neotropical Region, new taxa, dark taxa

Introduction

The Neotropical genus *Armillipora* Quate, 1996, remained monotypic until a second species was described in 2020 (Ježek et al. 2020). Recently, Jaume-Schinkel and Mengual (2024) described two more species, bringing the total to four. All species are known to occur in only five countries: Bolivia — *Armillipora suapiensis* Ježek, Oboňa & Le Pont, 2020; Costa Rica — *A. selvica* Quate, 1996; Ecuador — *A. imitata* Jaume-Schinkel & Mengual, 2024, *A. muyu* Jaume-Schinkel & Mengual, 2024, and *A. selvica*; Panama — *A. selvica*; and Nicaragua — *A. selvica* (Quate 1996, 1999; Ježek et al. 2020; Jaume-Schinkel and Mengual 2024).

After the taxonomic revision undertaken by Jaume-Schinkel and Mengual (2024), the author acquired additional specimens representing undescribed species. This publication aims to describe the new species and further discuss taxa within *Armillipora*.

Methods

In the material examined section and at the end of each record, the holding institution is stated. Specimen numbers or identifiers are enclosed within square brackets.

Specimens examined are deposited in the Natural History Museum of Los Angeles County, Los Angeles, California, USA; and Instituto Nacional de Pesquisas da Amazônia, Manaus, Brazil. Referred to in the text with the acronyms: LACM and INPA respectively.

Measurements

Head width was taken in the widest part, approximately above the insertion of the antennal scape, along the greatest width of the eyes. The head's length was taken from the vertex to the lower margin of the clypeus. The wing length was measured from the base of the wing at

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the start of the costal node to the wing apex; the wing width was taken approximately at an imaginary vertical line crossing the radial and medial forks, approximately at the wings' greatest width. Palpal segments proportions are given considering the length of the first palpal segment as a unit (1.0). Measurements are provided at the beginning of each description in millimeters, presented as a mean followed by a range in parentheses.

Terminology

We follow the general terminology proposed by Cumming and Wood (2017) and Kvifte and Wagner (2017).

Figures

The distribution map was created using QGIS version (3.28.6-Firenze) with the QuickMapServices plugin; further edited using Adobe Photoshop 2023 version 24.5.0. Species figure plates were combined and edited using Adobe Photoshop 2023 version 24.5.0.

Artificial intelligence usage

The Grammarly Google Chrome extension was used during the writing process for grammar and spelling checks.

Taxonomy

Class Insecta Linnaeus, 1758
Order Diptera Linnaeus, 1758
Suborder Psychodomorpha Hennig, 1968
Family Psychodidae Newman, 1834
Subfamily Psychodinae Newman, 1834

Genus *Armillipora* Quate, 1996

Armillipora Quate, 1996: 29. Type species *Armillipora selvica* Quate, 1996 (by original designation).

Armillipora – Quate (1999: 427) (new record); Ježek et al. (2020: 418) (updated diagnosis, redescription of type species, and description of new species); Jaume-Schinkel and Mengual (2024: 163) (differential diagnosis, description of new species, identification key).

Species included. *Armillipora bifida* sp. nov., *A. imitata* Jaume-Schinkel & Mengual, 2024, *A. muyu* Jaume-Schinkel & Mengual, 2024, *A. nawak* sp. nov., *A. selvica* Quate, 1996, *A. suapiensis* Ježek, Oboňa & Le Pont, 2020. Species distribution can be seen in Fig. 1.

Diagnosis. Antennal flagellomeres with a double row of alveoli placed in the center of flagellomeres (in females, the double row of alveoli is less conspicuous than in the males); flagellomeres with simple, paired and needle-shaped ascoids. Epandrial appendages irregularly asymmetrical, with a basal patch of accessory tenacula, a row of short, cylindrical tip-folded tenacula placed in the middle region, without apical tenacula. Gonocoxites reduced and often fused; the gonostyli can be reduced and fused (as in *A. selvica*, *A. imitata*, and *A. muyu*), or not reduced and clearly divergent (as in *A. suapiensis*, *A. bifida* sp. nov., and *A. nawak* sp. nov.). The female subgenital plate is longer than its width, with apical lobes separated by a broad concavity, and with a pair of long spines on the apical margin of the concavity.

Remarks. In the description of the type species (*Armillipora selvica*), the gonocoxites and gonostyli were described as unusual, adhering closely to the aedeagus, and challenging to discern (Quate, 1996). Later, in Ježek et al. (2020), the gonocoxites were described as fused in a swollen bag (together with the remainder of the parameres). Still, the gonostyli were free (as divergent sickle-shaped appendages). Likewise, in Jaume-Schinkel and Mengual (2024), the gonostyli were treated as absent (fused) for the two newly described species (*A. muyu* and *A. imitata*). Moreover, Jaume-Schinkel and Mengual (2024) stated in the diagnosis of *A. suapiensis* that the "gonocoxites are not fused"; this was a misinterpretation of the character. In reality, the gonocoxites are reduced and fused, while the correct character they were referring to is the gonostyli (which are indeed not fused, and clearly divergent). This misinterpretation resulted in an error in the initial couplet of the identification key, where the terms "gonocoxites not fused" or "gonocoxites fused" were used instead of referring to the gonostyli. This error has been rectified in the present publication, with the identification key now accurately reflecting this character.

Therefore, based on the fusion or the lack of fusion of the gonostyli, two species groups are now proposed within *Armillipora*. The *selvica* group, where the gonostyli are reduced and fused with the gonocoxites, including *A. selvica*, *A. imitata*, and *A. muyu*, and the *suapiensis* group, in which the gonostyli are not fused, and are clearly discernible and divergent from the fused gonocoxites, including *A. suapiensis*, *A. bifida* sp. nov., and *A. nawak* sp. nov.

Armillipora bifida sp. nov.

https://zoobank.org/20C320FF-267F-4F45-80EF-EEB98627B3FC

Figs 1–3

Differential diagnosis. *Armillipora bifida* sp. nov. belongs to the *suapiensis* group (gonostyli not fused), and it can be easily differentiated from all the species in the group by the bifurcated apex of the gonostyli (apex of gonostyli not bifurcated and sickle-shaped in *A. suapiensis*, apex not bifurcated with rounded apex in *A. nawak* sp. nov.).

Etymology. The species epithet *bifida* derives from the Latin word *bifidus* (feminine *bifida*), which refers to the bifurcated apex of the gonostyli. To be treated as an adjective.

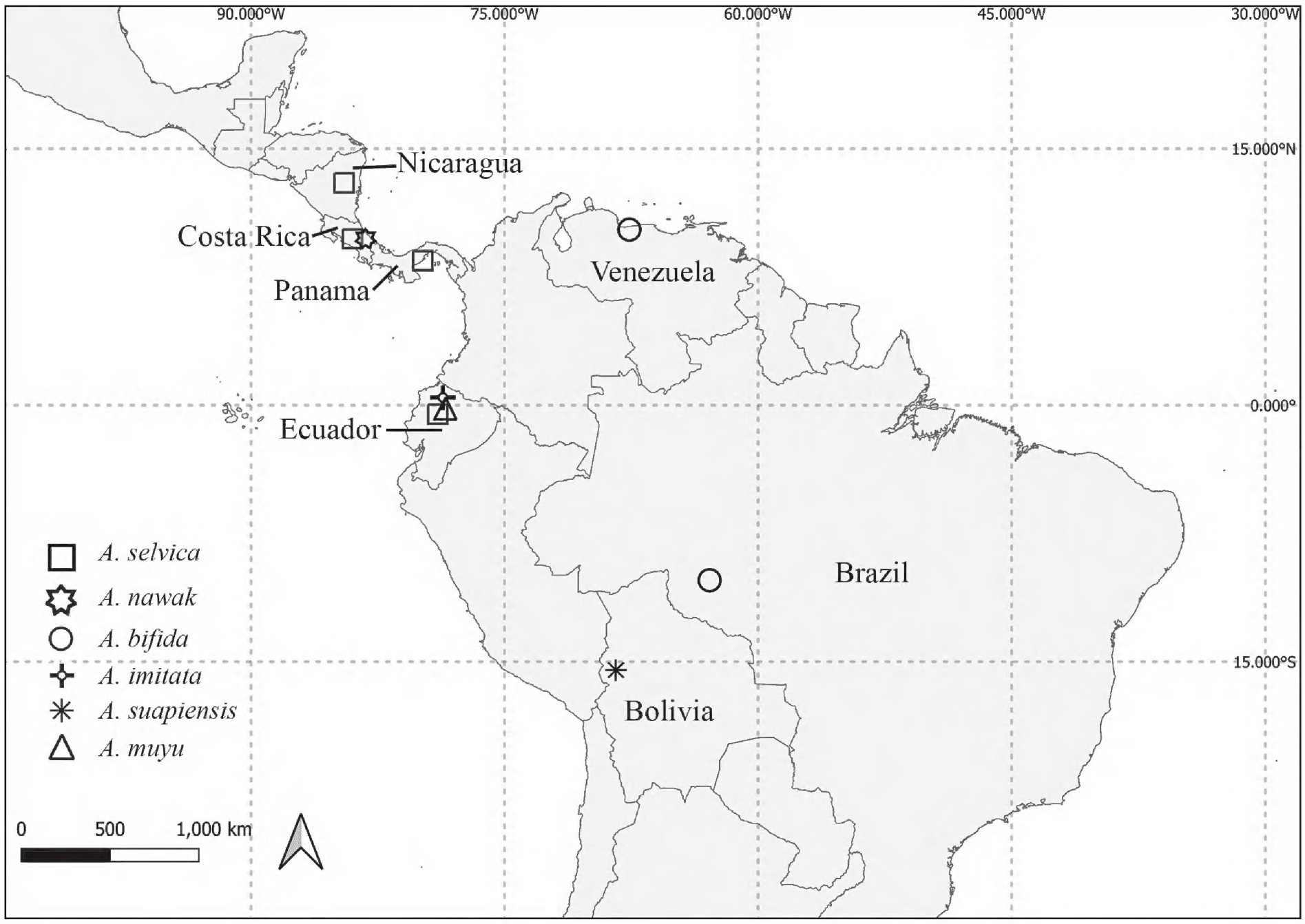

Figure 1. Distribution map of the species of *Armillipora* Quate.

Examined material. Venezuela – **Aragua** • 1 ♂; 25 km NW of Maracay, Aponte; alt. 50 m; 13–18 Jun. 2001; Malaise Trap; L.W. Quate & H. R. Bha legs.; slide mounted in Euparal; LACM [LACM ENT 272769].

Paratypes. Brazil – **Rondonia** • 2 ♂♂; 200 km SSE of Porto Velho, Cacaulandia; -10.3°N, -62.87°E; 25 May – 6 Jun. 1998; L.W. Quate leg.; Malaise Trap; slide mounted in Euparal; LACM [LACM ENT 272772], INPA [LACM ENT 272771].

Venezuela – **Aragua** • 1 ♂; Maracay; 14 Nov. 1993; L.W. Quate leg.; Light Trap; wooded hillside; slide mounted in Euparal; LACM [LACM ENT 272770].

Description. (N = 4). Wing length: 2.26 (2.25–2.27), width: 1.01 (1.00–1.02). Head length: 0.52 (0.55–0.50), width: 0.61 (0.61–0.61). Antennal segments: scape: 0.15 (0.15–0.16); pedicel: 0.07 (0.07–0.08); flagellomeres 1: 0.13 (0.13–0.13), flagellomeres 2–12: 0.15 (0.15–0.15), flagellomere 13: 0.11 (0.11–0.11), flagellomere 14: 0.13 (0.13–0.13). Palpal segment 1: 0.08 (0.07–0.08); palpal segment 2: 0.10 (0.10–0.10); palpal segment 3: 0.11 (0.11–0.11); palpal segment 4: 0.18 (0.18–0.19).

Male. Head (Fig. 1A). About 1.20 times wider than its length; eye bridge separated by one facet's diameter, with five rows of facets; interocular suture straight; the frontal patch of alveoli divided. Antennal scape about 2.00 times the length of the pedicel, almost cylindrical; pedicel spherical; flagellomeres fusiform and longer than scape, with scattered setae on the surface, setae almost as long as the flagellomere bearing them, each flagellomere with two rows of alveoli placed at the center, apical flagellomere with terminal apiculus; ascoids undistinguishable in examined material. Palpal segments cylindrical, palpal proportions: 1.0:1.2:1.3:2.2, last palpal segment corrugated; labium without any strong sclerites; labella elongated and irregularly shaped scattered setae on the surface, with one apical spiniform tooth on each.

Thorax (Fig. 1B). It does not present allurement organs, with a single patch of alveoli in the paratergite and antepronotum; all coxae with a stripe of one to two rows of alveoli. Wing (Fig. 1C) about 2.20 times longer than its width; wing membrane brown–infuscate, with lightened (white) spots between the apex of longitudinal veins; these spots are located before the apex of R_1, between R_2 and R_3, between R_3 and R_4, between M_3 and M_4, and between M_4 and CuA; Sc vein short, ending beyond the origin of R_1; radial fork slightly basal to medial fork; R_{2+3} not joining R_4; R_5 ending at the wing apex; CuA ending at wing margin.

Terminalia (Figs 2D, 3A–D). Hypandrium on ventral view appears significantly reduced, not sclerotized and joining the base of the reduced gonocoxites; gonostyli not reduced, clearly divergent and both with bifurcated apex (as in Fig. 3A); aedeagus on ventral view straight,

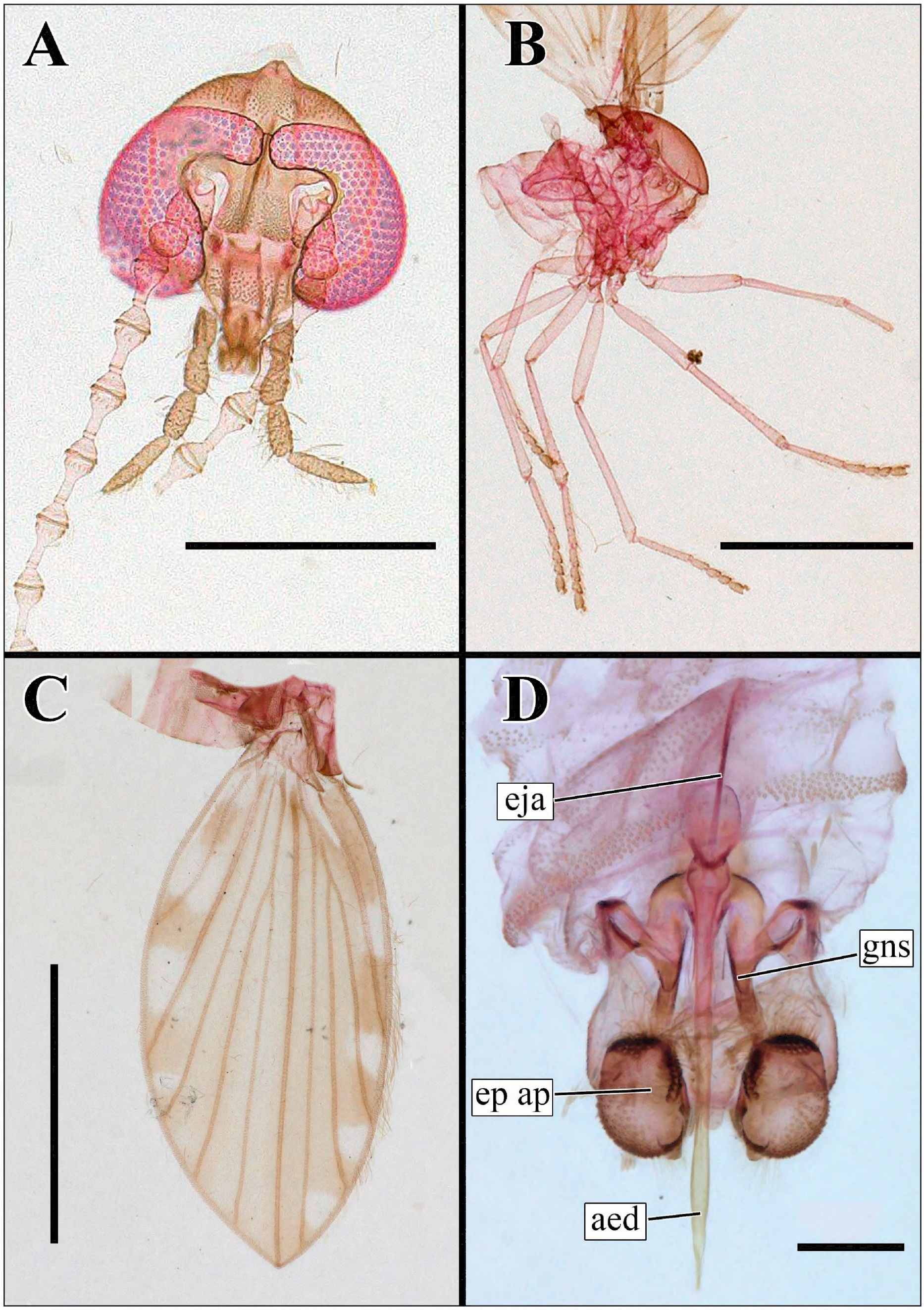

Figure 2. *Armillipora bifida* sp. nov. **A.** ♂, paratype (LACM ENT 272771); **B–D.** ♂, paratype (LACM ENT 272772). **A.** Head; **B.** Thorax; **C.** Wing; **D.** Genitalia, ventral view. Abbreviations: aed = aedeagus; eja = ejaculatory apodeme; ep ap = epandrial appendage. Scale bars: 0.50 mm (**A**); 1.00 mm (**B–C**); 0.10 mm (**D**).

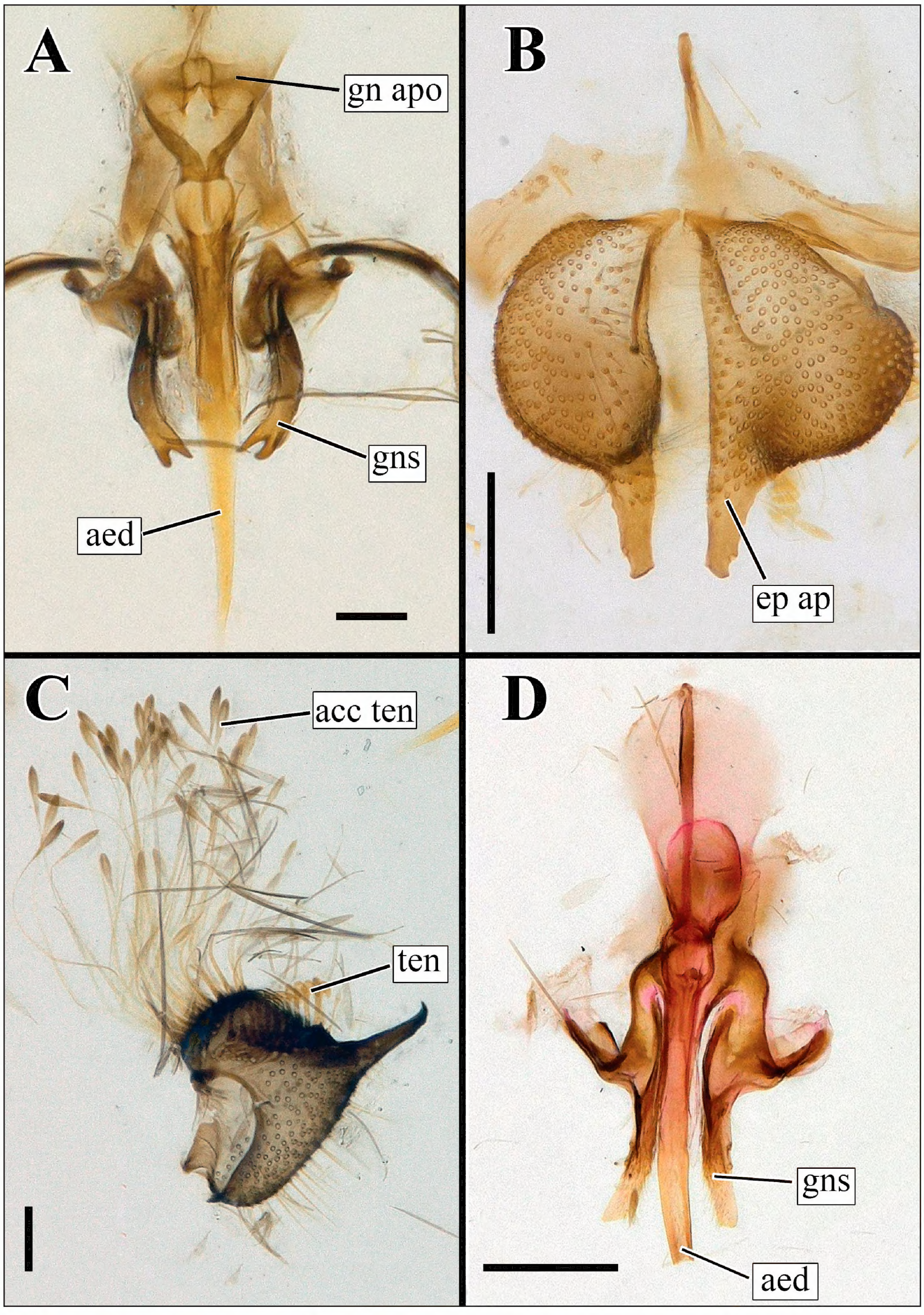

Figure 3. *Armillipora bifida* sp. nov. **A, C** ♂, holotype (LACM ENT 272769); **B** ♂, paratype (LACM ENT 272770); **D** ♂, paratype (LACM ENT 272771). **A.** Genitalia, ventral view; **B.** Epandrial appendages, dorsal view; **C.** Epandrial appendage, lateral view; **D.** Aedeagus, ventral view. Abbreviations: acc ten = accessory tenacula; aed = aedeagus; ep ap = epandrial appendage; gn apo = gonocoxal apodeme; gns = gonostylus; ten = tenacula with folded tip. Scale bars: 0.10 mm (**A–D**).

as a single sclerite, ending beyond the apex of the gonostyli (Figs 2D, 3A); the ejaculatory apodeme is about the half the length of the aedeagus, on ventral view the basal margin is rounded; no discernible parameres; gonocoxal apodemes fitting in a concavity on the underside of the ejaculatory apodeme (Fig. 3A); epandrium rectangular (Fig. 2D); hypoproct tongue-shaped and covered in setulae, epiproct not observed; epandrial appendage (Figs 1D, 2B–C) barely hemispherical at base, prolonged and tapering distally, and covered with small setae, lacking apical tenacula; distal tapering of the epandrial appendage (Fig. 3B–C) about half the length the basal hemispherical portion; medial portion of the epandrial appendage with row of 10–11 tenacula that are short and cylindrical, with folded tips; the epandrial appendage possess a basal patch of long accessory tenacula concentrated in a darkened patch, and longer than the epandrial appendage.

Female. Unknown.

Distribution. The species is only known from the localities in Venezuela and Brazil (Fig. 1).

Notes. In the paratype LACM ENT 272772, the apex of the gonostyli and the apex of the aedeagus are broken and not present in the slide (as seen in Fig. 3D). Nonetheless all other characters fit with the description.

Armillipora nawak sp. nov.

https://zoobank.org/33A151A9-81BF-41DF-A36C-949297C1DB78

Figs 1, 4–5

Differential diagnosis. *Armillipora nawak* sp. nov. belongs to the *suapiensis* group (gonostyli not fused). It can be easily differentiated from all the species in the group by the digitiform gonostyli with rounded apex (apex of gonostyli bifurcated in *A. bifida* sp. nov., and apex of gonostyli pointed and sickle-shaped in *A. suapiensis*); the gonostyli are as long as the aedeagus (shorter than the aedeagus in *A. bifida* sp. nov., and *A. suapiensis*); the apex of the aedeagus with two digitiform sclerotized structures (apex of the aedeagus pointed without sclerotized structures in *A. bifida* sp. nov., and in *A. suapiensis*).

Etymology. The species epithet *nawak* derives from the Cabécar word: "*ñą̀wák*", commonly used to refer to synanthropic psychodines. To be treated as a name in apposition.

Examined material. Costa Rica – **San Jose Moravia** • 1 ♂; Zurqui de Moravia; 10.0492°N, -84.0037°E; alt. 1600 masl; 22 Oct.–01 Nov. 2012; ZABDI project leg.; Malaise Trap ZABDI-186; LACM [INB0004346462-INBIOCRI]. ***Paratype.*** Costa Rica – **Punteras** • 1 ♂; Coto Brus, Las Tablas, Estacion Biologica Las Alturas; 8.9519°N, -82.8322°E; 1500 masl; 01 Jan.–07 Jan. 2013; ZABDI project leg.; Malaise Trap ZABDI-544; LACM[INB0004415321].

Description. (N = 2). Wing length: 3.02, width: 1.09. Head length: 0.50, width: 0.60. Antennal segments: scape: 0.12); pedicel: 0.07; flagellomeres 1–4 0.17, flagellomeres 5–14 missing in examined material. Palpal segment 1: 0.10, palpal segments 2–4 missing in examined material.

Male. Head (Fig. 4A). About 1.20 times wider than its length; eye bridge separated by about half facet's diameter, with four rows of facets; interocular suture absent; the frontal patch of alveoli is divided. Antennal scape almost cylindrical, about 1.66 times the length of the spherical pedicel; flagellomeres fusiform and longer than the scape, with scattered alveoli in the surface; each flagellomere with two rows of alveoli; flagellomeres after the fourth absent in examined material; ascoids undistinguishable in examined material. First palpal segment cylindrical; labium without any strong sclerites; labella elongated and teardrop-shaped, with 5–6 scattered setae on the surface and with one apical spiniform tooth on each.

Thorax (Fig. 4B). It does not present allurement organs, with a single patch of alveoli in the praterguite and antepronotum; all coxae with a stripe of one to two rows of alveoli. Wing (Fig. 4C) length about three times its width; wing membrane hyaline, with darkened spots in the apex of longitudinal veins (as seen in Fig. 4C); Sc vein short ending at the origin of R_1; radial fork basal to medial fork; R_{2+3} not joining R_4; R_5 ending at the wing apex; CuA ending at wing margin.

Terminalia (Figs 4D–E, 5). Hypandrium on ventral view band-like, sclerotized and joining the base of the reduced gonocoxites; gonostyli not fused with gonocoxites and clearly divergent, digitiform with a rounded apex (as in Fig. 4D–E, 5), each gonostylus with two apical and one subapical alveoli; aedeagus on ventral view straight, basal 2/3rds looking like a single shaft, while apical third as two distinct heavily sclerotized digitiform structures, the aedeagus ends beyond the apex of the gonostyli; ejaculatory apodeme slightly shorter than the aedeagus, broader on the base, and tapering towards its apex, in ventral view the basal margin is rounded, and the width of the basal margin is the same as the length of the ejaculatory apodeme; parameral sclerites seem absent; gonocoxal apodemes (Figs 4D, 5) fitting in a concavity on the underside of the ejaculatory apodeme, and joining the reduced gonocoxites; epandrium rectangular (Fig. 5), about 3 times wider than its length; hypoproct tongue-shaped and covered in setulae, epiproct not observed; epandrial appendages (Figs 4D–E, 5) barely hemispherical, prolonged and tapering distally, covered with setae; epandrial appendages with one preapical, tip-folded and short tenacula (Fig. 5) with a basal darkened patch of accessory tenacula, the accessory tenacula varies in length, from shorter to longer than the epandrial appendages (Figs 4D, 5).

Female. Unknown.

Distribution. The species is only known from the type locality in Costa Rica (Fig. 1).

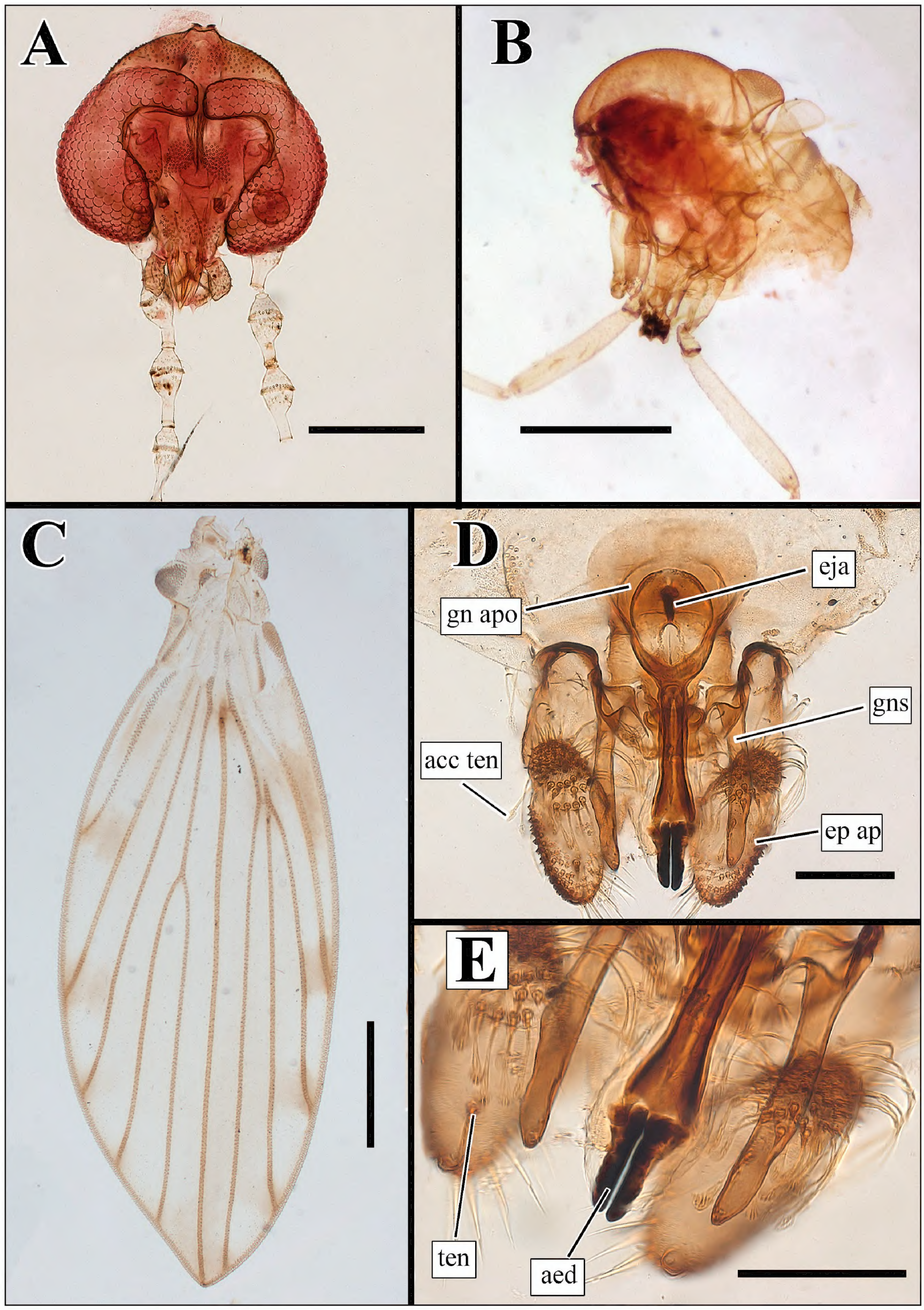

Figure 4. *Armillipora nawak* sp. nov. **A–E** ♂, holotype (INB0004346462). **A.** Head; **B.** Thorax; **C.** Wing; **D.** Genitalia, ventral view; **E.** Aedeagus, ventral view. Abbreviations: acc ten = accessory tenacula; aed = aedeagus; eja = ejaculatory apodeme; ep ap = epandrial appendage; gn apo = gonocoxal apodeme; gns = gonostylus; ten = tenacula with folded tip. Scale bars: 0.25 mm (**A**); 0.10 mm (**B**); 0.50 mm (**C**); 0.10 mm (**D–E**).

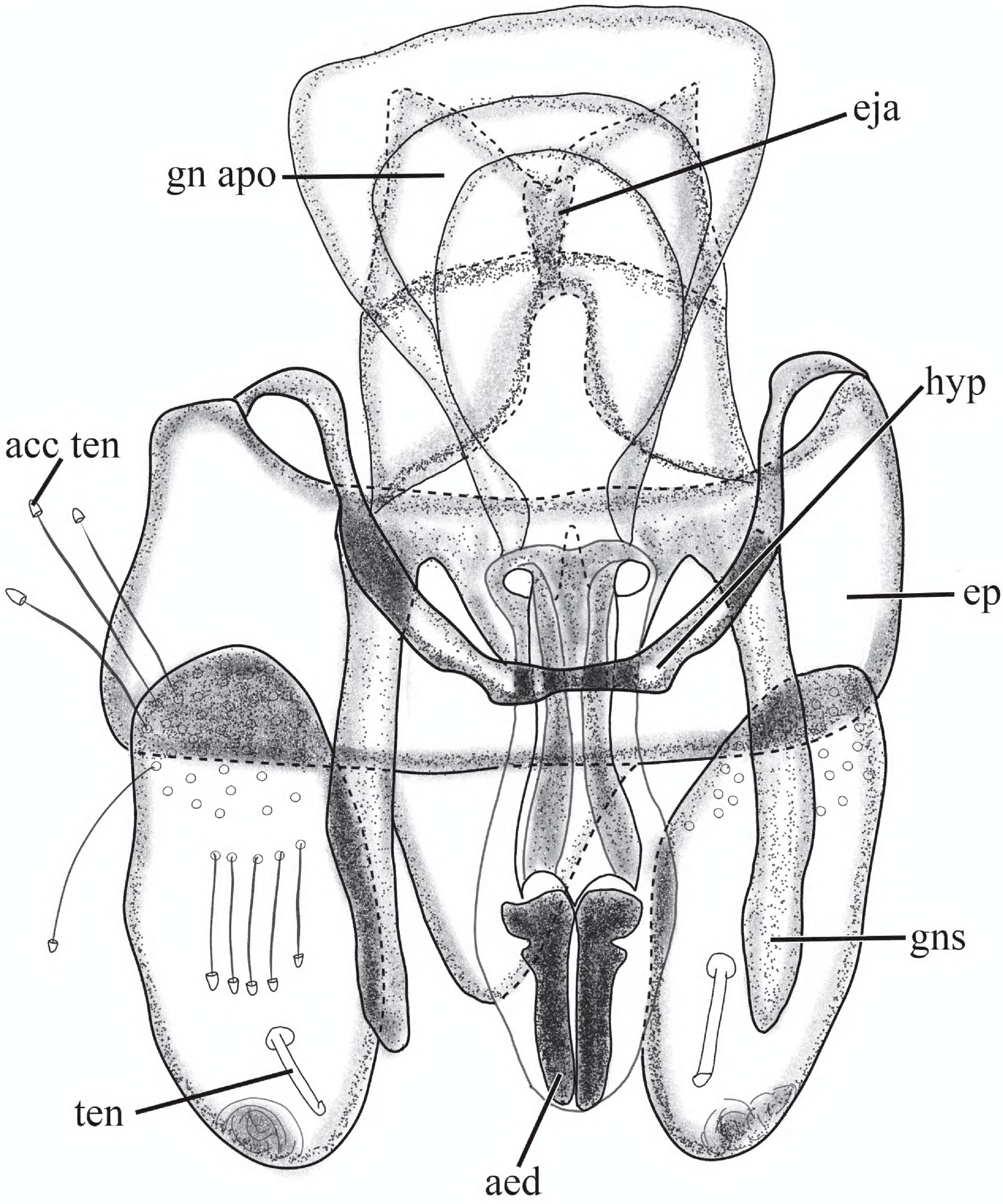

Figure 5. *Armillipora nawak* sp. nov. ♂, holotype (INB0004346462). Genitalia, ventral view. Abbreviations: acc ten = accessory tenacula; aed = aedeagus; eja = ejaculatory apodeme; ep ap = epandrial appendage; gn con = gonocoxal condyle; gns = gonostyli; hyp = hypandrium; ten = tenacula with folded tip. Scale bar: 0.10 mm.

Key to the males of *Armillipora*

1 Gonostyli not fused and discernible from the fused gonocoxites (as in Figs 3A, 4D) [*suapiensis* group] 4
– Gonostyli fused and not discernible from the fused gonocoxites (as in Quate (1996) fig. 11 G) [*selvica* group] 2

2 Interocular suture with a short posterior spur (as in Ježek et al. (2020) fig. 1); gonocoxal apodemes triangular-shaped and protruding beyond the base of the ejaculatory apodeme (as in Quate (1996) fig. 11G; Jaume-Schinkel and Mengual (2024) fig. 6B) ..... *A. selvica* Quate
– Interocular suture without a posterior spur (see Jaume-Schinkel and Mengual (2024), figs 1A and 3A); gonocoxal apodemes variable in shape, but not triangular-shaped and not protruding beyond the base of the ejaculatory apodeme..... 3
3 Gonocoxites fused, forming U-shaped sclerite, concave at the lower margin; gonocoxites without preapical lumps, each containing six preapical setae (see Jaume-Schinkel and Mengual (2024) figs 1C and 2B); epandrial appendage in lateral view with a line of four short and cylindrical tenacula; epandrial appendage with additional separate projection bearing one tenaculum (see Jaume-Schinkel and Mengual (2024) fig. 2E)..... *A. imitata* Jaume-Schinkel & Mengual
– Gonocoxites fused, forming V-shaped sclerite (see Jaume-Schinkel and Mengual (2024) figs 3C and 4B), each with a preapical lump, each containing three to four setae; epandrial appendage in lateral view with a line of five short and cylindrical tenacula; epandrial appendage without additional projection (see Jaume-Schinkel and Mengual (2024) fig. 4G) ..... *A. muyu* Jaume-Schinkel & Mengual
4 Gonostyli length about the same length as the aedeagus (Figs 4B, 5); gonostyli digitiform (Figs 4B, 5); epandrial appendages with single tip-folded tenacula (besides the patch of accessory tenacula) (Figs 4B, 5) ..... *A. nawak* sp. nov.
– Gonostyli length about half or less than half the length of the aedeagus (Fig. 2A–B); epandrial appendages with a row of 5–10 tip-folded tenacula (besides the patch of accessory tenacula) (Fig. 2D)..... 5
5 Gonostyli resembling a curved, crescent-shaped blade (sickle-shaped), with a pointed apex, without bifurcation (see Ježek et al. (2020) fig. 37); the anterior margin of ejaculatory apodeme is pointed, narrower than the posterior margin (as in Ježek et al. (2020) fig. 37) ..... *A. suapiensis* Ježek, Oboňa & Le Pont
– Gonostyli digitiform with a bifurcated apex, not resembling a curved and cresent-shaped balde (not sickle-shaped) (Fig. 3A); anterior margin of the ejaculatory apodeme rounded, broader than the posterior margin (Figs 2D and 3A,D) ..... *A. bifida* sp. nov.

Discussion

The species within the *selvica* group exhibit striking morphological similarities. According to Jaume-Schinkel and Mengual (2024), precise morphological identification relies on discerning subtle characters in the male genitalia. They assert that combining morphological data with COI DNA barcodes offers valuable insights for accurate species delimitation within this group. In contrast, the *suapiensis* group showcases a higher diversity of morphological characters within the male genitalia. Species in this group can be easily differentiated from one another based solely on male genital characters. However, the absence of published DNA barcodes for any species within the *suapiensis* group impedes molecular species delimitation efforts. Nevertheless, it is expected that the integration of morphological and molecular data will undoubtedly enrich our understanding of species boundaries and aid in future species descriptions and recognition within this genus.

The distribution model outlined by Jaume-Schinkel and Mengual (2024) suggested a broad potential range for the genus *Armillipora* across several countries, including Brazil, Colombia, French Guyana, Guyana, Peru, Surinam, and Venezuela. This study supports the model projection by recording the genus for the first time in Brazil and Venezuela. This finding underscores the importance of predictive models in guiding fieldwork and highlights the likelihood of further geographical records across the Neotropical region.

By adopting integrative taxonomy methods that merge diverse datasets, including morphology, molecular analyses, geographical distribution, and ecological data, we have a unique opportunity to bridge the existing knowledge gap within Psychodidae species, particularly in the neotropical region.

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